Manufacturing Innovation and Technological Superiority

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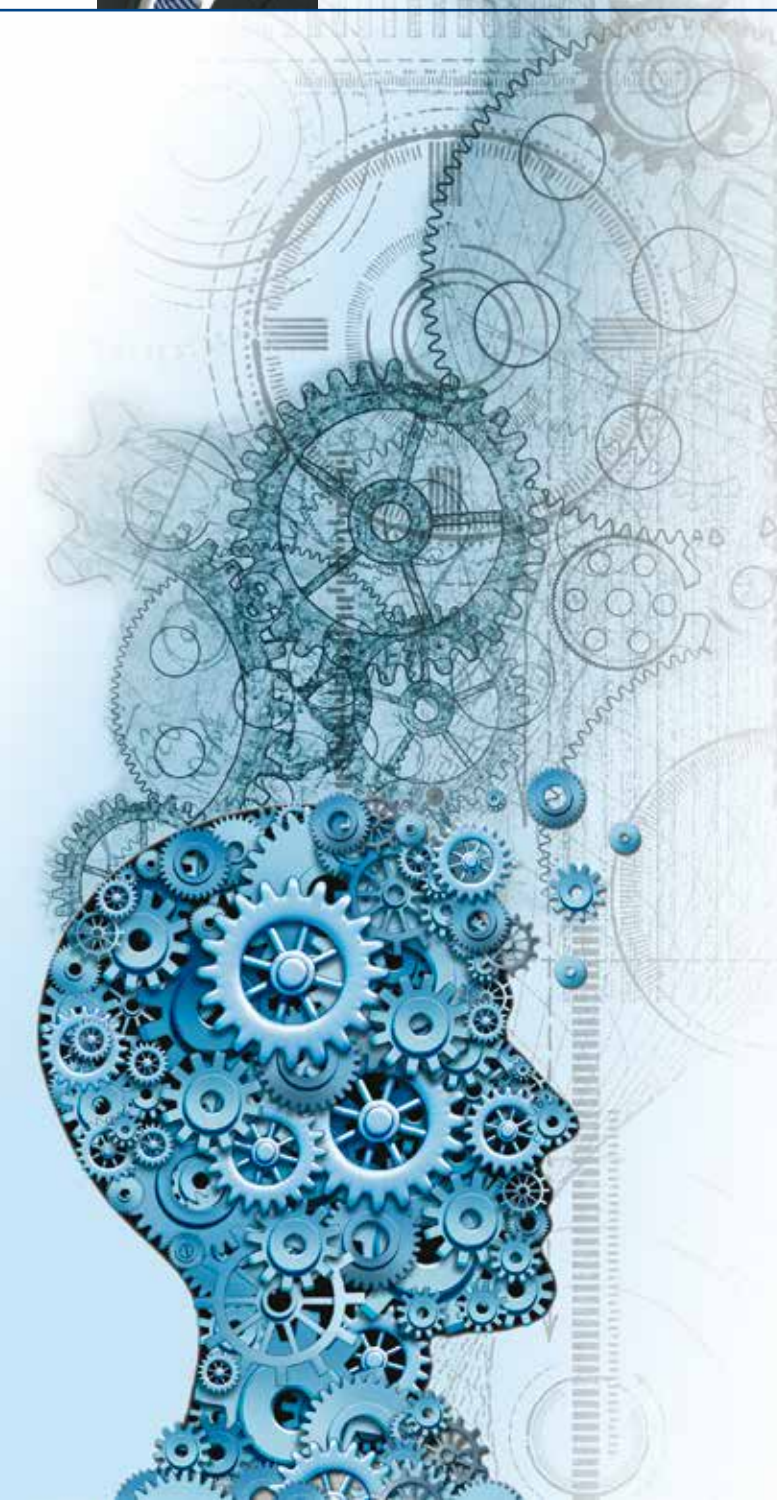


At the end of the Cold War, I was serving as the Deputy Director of Defense Research and Engineering for Tactical Warfare Programs in the Office of the Secretary of Defense (OSD). For years I had studied the intelligence reports on Soviet weapon systems and worked on ways the United States could achieve or maintain a military advantage over those systems. We knew the Russians had some of the best scientists and engineers in the world working on their designs. They also had aggressive modernization cycles in areas they considered important; their multiple competing design bureaus turned out new designs for armored vehicles, missiles and tactical aircraft on a predictable schedule at intervals of about 5 years.

After the Cold War ended, I was anxious to get a close look at the Soviet weapons systems we had been working to defeat. I soon had two opportunities to examine the newest Soviet equipment up close. One was a display at Andrews Air Force Base in Maryland of all the equipment that we acquired to test once the wall came down and the Russians were desperate for any source of cash. The other was at the Farnborough International Airshow in England, where the Russians were offering to sell their most modern systems to anyone who would buy them. What struck me most when I examined the former Soviet equipment was how primitive their production technology was compared to U.S. manufacturing technology.

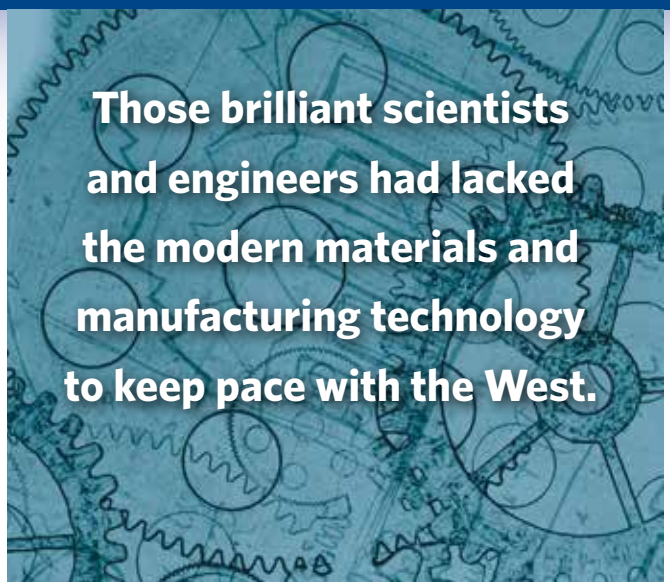
Those brilliant scientists and engineers had lacked the modern materials and manufacturing technology to keep pace with the West. It was clear that the performance and reliability of their

weapons systems had been severely limited by their limitations in areas like precision machining; the ability to fabricate multilayer printed circuit boards; and their inability to produce integrated circuits.

I recall in particular the presence of Bakelite, a distinct early plastic thermosetting insulating material, which the United States hadn't used since the 1950s, being everywhere in Soviet 1980s-era aircraft. One of the greatest constraints on the Soviet designers, and on the performance and cost of their weapons systems had been manufacturing technology.

Manufacturing technology doesn't just affect weapons systems and technological superiority—it also drives national economic performance. The first and second industrial revolutions were largely about manufacturing technology. The English advantages in mechanized textile manufacturing in the early 1800s drove the performance of the British economy, just as Carnegie's steel production in the late 19th century and Ford's mass production technology early in the 20th drove the growth of the U.S. economy. More recently, ever smaller and more efficient silicon-based integrated circuits that can be economically manufactured in massive quantities are driving economic growth around the world.

Recognizing the importance of manufacturing technology to both national security and our economy, the President initiated a program to establish Manufacturing Innovation Institutes (MIIs) that would create incubators for advanced manufacturing technology in key technological areas. The Department of Defense (DoD) has been a national leader in establishing these institutions. With the Acting Secretary of Commerce and the National Economic Advisor, I opened the first one—which is dedicated to advancing additive manufacturing (3D printing) technology—in Youngstown, Ohio, in 2012. Since then, several more MIIs have been opened, two by the Department of Energy and six by the DoD. Several more are on the way. The technologies of interest are determined by an expert interagency body with industry input. Focus areas include lightweight alloys, digitization of design to manufacturing processes and flexible electronics. All of these new institutions depend on collaboration between federal and local government, industry and academia. Government funding is combined with other sources of funds to get these institutions up and running, but they will have to be self-sufficient in a few years when government funding will cease. We don't know if every MII will flourish; we will let time and the requirement to be self-sufficient sort that out. Four years in we do know that some of the MIIs we have established are off to a good start, with continuing interest from industry, significant advances in manufacturing technology and successful products to their credit.



I would like to recognize some key DoD leaders who have organized and led the competitive process to set up the MIIs. First Brett Lambert, then Elana Broitman, and now Andre Gudger, as leaders of the DoD's Manufacturing and Industrial Base Policy organization, have been the senior leaders responsible for the DoD's MIIs. A remarkable team, led by Adele Ratcliff (whose article in this edition of *Defense AT&L* magazine provides much more detail on the MIIs), has done the heavy lifting required to make each of the MIIs a reality. Each of the Military Departments also has played a strong role—conducting the actual competitions and working with the selected consortium to get the MIIs up and running. All of these dedicated professionals deserve our appreciation for creating these new national assets.

While the MIIs are important, they are only one source of the technologies that will make building our future generations of weapons possible and affordable. Industry investments are focused on staying competitive in an ever-more-competitive world, and help to keep the United States competitive against potential adversaries.

I have been encouraging defense companies to invest more in research and development, and one of the areas of greatest promise is on technologies that will lower the production costs and improve the performance of our weapons systems. Industry is responding. One example is the "blueprint for affordability" initiative in which Lockheed Martin and major F-35 suppliers have agreed to undertake to reduce F-35 production costs. Through a creative "win-win" agreement, Lockheed Martin and the major suppliers for the F-35—Northrop Grumman and BAE—are all making investments that will reduce government cost and achieve a higher return for the industry participants. Pratt & Whitney has a similar program for the F-135 engine. In another example, Boeing has invested significantly in its

groundbreaking proprietary manufacturing processes that are expected to pay strong dividends in both military and commercial aircraft manufacturing. Industry understands that manufacturing technology is the key to competitiveness.

For more than 50 years, the DoD Manufacturing Technology Program, or ManTech, has been used by the DoD to sustain our lead in defense-essential manufacturing capability. The ManTech Program, executed through dedicated teams in the Services, agencies, and within the OSD, develops technologies and processes that impact all phases of acquisition and reduce both acquisition and total ownership costs by developing, maturing, and transitioning key manufacturing technologies. ManTech not only provides the crucial link between technology invention and development and industrial applications, but also matures and validates emerging manufacturing technologies to support feasible implementation in industry and DoD facilities like depots and shipyards.

Direct investments by the government have often been the genesis of new manufacturing technology and a catalyst to spur more investment by industry. When I was vice president of engineering at Raytheon in the 1990s, I was able, with the CEO's strong support, to protect our corporate investment in the technology needed to produce gallium arsenide radio frequency components, a key enabler for a range of important national security projects and a major competitive advantage for the company. More recently, government support, together with industry investments, for Gallium Nitride components is giving the United States the opportunity to produce systems like the Next Generation Jammer, the Advanced Missile Defense Radar and others.

For the acquisition professionals managing our new product development programs, manufacturing technology and the risk associated with bringing new technology on line, should be major partsof program planning. Our policy encourages the use of Manufacturing Readiness Levels as one way to assess the maturity and risk associated with producing specific designs. As I hope you know by now, I'm not a fan of readiness levels—they convey no real information about the actual risk or the difficulty of maturing a technology to where it can be used in a product or in manufacturing a product—but they do provide a place to start a conversation about that risk. Managing the risk associated with manufacturing is as important as managing the technological risk associated with performance. This isn't a new problem. When I was working on my MBA in the 1970s, we did a case study on how to manage creative designers who failed to appreciate the difficulty associated with actually producing their ingenious designs. While a new idea might work in theory, if it can't be built at an affordable cost it doesn't have much value. As we build risk reduction plans and proactively manage the risks associated with new capabilities we cannot afford to neglect the importance of having mature manufacturing processes.

Given the importance of manufacturing technology, we must protect that technology just as we protect the actual designs and performance characteristics of our weapon systems. As I work with our international partners, one thing is almost a constant—the desire to acquire advanced manufacturing expertise in order to build more competitive manufacturing capacity and create jobs. Our competitors as well as our friends understand the importance of manufacturing technology, and they have no reticence about using every available means to acquire that technology—especially cyber theft. As we build Program Protection Plans, we must include the steps we will take to protect critical manufacturing technology—throughout the supply chain.

This issue of *Defense AT&L* magazine is focused on manufacturing, the various MIIs and on our programs, such as ManTech, established to invest in critical manufacturing technology. As we plan and execute our research efforts and our development programs, we all should be conscious of the importance of advancing the state of the art in manufacturing, of managing the risks associated with manufacturing, and of protecting the manufacturing technologies that we need to maintain our technological superiority over our most capable potential opponents. You can be certain that potential adversaries are working very hard to avoid the disadvantage embedded in the Soviet weapon systems I was so anxious to investigate at the end of the Cold War.